

RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER QUARTERLY PROGRESS REPORT

Wisconsin Department of Transportation
DT1241 02/2011

INSTRUCTIONS:

Research project investigators and/or project managers should complete a quarterly progress report (QPR) for each calendar quarter during which the projects are active.

WisDOT research program category: <input type="checkbox"/> Policy research <input type="checkbox"/> Other <input checked="" type="checkbox"/> Wisconsin Highway Research Program <input type="checkbox"/> Pooled fund TPF#		Report period year: 2014 <input checked="" type="checkbox"/> Quarter 1 (Jan 1 – Mar 31) <input type="checkbox"/> Quarter 2 (Apr 1 – Jun 30) <input type="checkbox"/> Quarter 3 (Jul 1 – Sep 30) <input type="checkbox"/> Quarter 4 (Oct 1 – Dec 31)
Project title: Laboratory Study of Optimized Concrete Pavement Mixtures		
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WisDOT project ID: 0092-13-04	Other project ID: PRJ63JN	Project start date: 8/1/2012
Original end date: 1/31/2015	Current end date: 1/31/2015	Number of extensions: 0

Project schedule status:

☒ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Project budget status:

Total Project Budget	Expenditures Current Quarter	Total Expenditures	% Funds Expended	% Work Completed
199185	2799	127568	64	70

Project description:

The Wisconsin Department of Transportation (WisDOT) continues to investigate the feasibility of optimization of paving mixtures as a means to improve the engineering properties, lower the required cementitious materials content, reduce cost, and minimize the environmental impacts. Previous research conducted by WisDOT concluded that concrete produced with reduced cementitious materials content had an adequate durability; however, these mixes frequently demonstrated poor workability. As a result, a multi-faceted approach to optimizing mixture proportioning for low-slump mixtures used in concrete pavements is needed for WisDOT to realize the benefits related to the use of lower cementitious materials contents. This approach includes the use of supplementary cementitious materials (SCMs), optimized aggregate gradations, and the use of superplasticizers (high-range water reducing, HRWR admixtures). Current WisDOT practice minimizes the use of portland cement through replacement with SCMs, but does not address the use optimized gradation or superplasticizers. Therefore, additional research is needed to support the development of specifications inclusive of the aforementioned factors to improve the performance and sustainability of concrete paving mixtures used in Wisconsin. This research project evaluates the feasibility of expanding current specifications to incorporate optimized superplasticized concrete in sustainable concrete paving applications.

The goal of this study is to produce guidelines for optimized concrete mix design by evaluating the performance of a range of concrete mixtures. The proposed performance evaluation of optimized concrete will include workability (slump and VB-test), air content, unit weight, compressive and flexural strength, freeze-thaw resistance, and rapid chloride permeability in accordance with relevant AASHTO/ASTM standards. The results of the research will be used to recommend the aggregate gradations and dosage of superplasticizers/HRWR admixtures that will accommodate the use of reduced cementitious materials for the low-slump concrete paving mixtures.

To provide the comprehensive optimization of superplasticized concrete, the proposed project will focus on the following objectives:

1. Develop a detailed, final testing matrix for comprehensive testing of aggregate gradations, SCMs and HRWR admixtures in concrete.
2. Evaluate and compare the composition, microstructural features, and physical properties of different types of cementitious materials essential for their compatibility with HRWR admixtures affecting their performance in concrete.
3. Evaluate the effect of HRWR admixtures on the fresh properties and mechanical performance of concrete.
4. Evaluate the effect of aggregate gradations on the fresh properties and mechanical performance of concrete.
5. Evaluate the effect of SCMs and HRWR admixtures on the stability of air void system, fresh properties, mechanical performance, and durability of concrete.
6. Develop and recommend for practical application an express-method capable of evaluating the performance of SCMs and HRWR admixtures in concrete.
7. Provide Life Cycle Analysis of sustainable optimized concrete paving applications based on the experimental results; submit a final report and recommendations for future work and revision of current specifications.

Progress this quarter

During the 1st Quarter of 2014, testing for packing degree of northern aggregates was accomplished. 21 preliminary batches (20 liters) were produced to optimize the Northern aggregates and optimization for these aggregates was achieved. Additional 3 preliminary batches were produced to further study the best ternary aggregate blend based on fresh and hardened properties.

Two types of portland cement were considered for testing in big batches using Northern aggregates (106 liters each). A total of 6 big batches were produced with optimal chemical admixture dosages. Of these batches, some samples will be shipped to UW-Madison for rapid chloride permeability and freeze-thaw testing, while others have been tested for compressive and flexural strength at 1, 3, and 7 days and will be tested for compressive and flexural strength at 28 and 90 days and compressive strength at 360 days. Initial length change measurements have been performed and will continue to be performed for these batches. Durability testing related to the 1st stage of the project (optimization of Southern aggregates) was completed at UW-Madison. The durability test results are analyzed. New type of cement for the remaining big batches was ordered and expected for shipment to the University of Wisconsin Milwaukee.

Anticipated work next quarter:

Work that is expected to be completed in the next quarter includes the production of 21 big batches to be shipped to Madison for durability testing. Compressive strength, flexural strength, and length change measurements on new and old samples will continue.

Durability tests that will be performed using Northern aggregates will include rapid chloride permeability and freeze-thaw testing for three sets of cements. Length change measurements due to shrinkage will also be continued.

Also, synchronizing the optimal dosage of chemical admixtures from mortars to concrete mixtures, and correlating early strength of mortar and concrete mixtures will be investigated. This follow-up step will further explore the empirical relationships between the results of express-tests and concrete properties and will evaluate the principal parameters affecting the performance.

The research team will provide the statistical analysis of experimental data; develop the relationships between the experimental factors and compare these with AASHTO/WisDOT/ACI requirements.

Circumstances affecting project or budget: None

Attach / insert Gantt chart and other project documentation Enclosed

FOR WISDOT USE ONLY

Staff receiving QPR:	Date received:
Staff approving QPR:	Date approved:

Gantt Chart / Work Time Schedule

